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**FREEZE-UP, BREAKUP, AND DATE OF MAXIMUM ICE THICKNESS FOR THE
ST. LAWRENCE RIVER--1971-81**

Gordon M. Greene

**Great Lakes Environmental Research Laboratory
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**UNITED STATES
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**Malcolm Baldrige,
Secretary**

**NATIONAL OCEANIC AND
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**John V. Byrne,
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FREEZE-UP, BREAKUP, AND DATE OF MAXIMUM ICE THICKNESS FOR THE
ST. LAWRENCE RIVER--1971-81*

Gordon M. Greene

This report summarizes 10 years of ice cover observations (1971-81) for 12 stations along the international section of the St. Lawrence River. For each station and season, the tables list date of freeze-over, date ice free, duration of solid ice cover, maximum ice thickness, and date of maximum ice thickness. Mean dates of freeze-over range from January 1 to January 17, while mean dates of ice free conditions range from February 25 to March 23. The longest mean ice cover duration is 79 days and the shortest is 48 days. The mean maximum ice thickness varies between 23 cm and 56 cm. The mean date of this maximum is as early as February 9 and as late as March 5. Observations were taken during a period that contained 5 winters colder than normal and 5 winters warmer than normal, when compared to an 80-year record of air temperatures.

1. INTRODUCTION

The timing of ice cover freeze-over and breakup in the Great Lakes exerts considerable influence on the use of the lakes. It should be realized, however, that it is variability of the ice cover chronology rather than the mere presence of ice that most disrupts human activity. That is, if the ice cover on the Great Lakes were seasonally consistent in when and where it formed, grew, and broke up, one could plan accordingly with a reasonable amount of lead time. Ice cover conditions are highly sensitive to meteorological conditions, however, and the experience of one winter offers little information about the next winter. Indeed, during any one season, conditions from month to month are poorly correlated.

In the face of such variability, one must be able to estimate the range of possibilities and to balance the need for certainty against the chance of risk. This is particularly true in the connecting channels in the Great Lakes system, where the operation of ships and hydropower complexes can be easily disrupted by changes in ice conditions.

This report summarizes available data on the dates of freeze-up and breakup for the 1972-81 winter seasons. Its purpose is to aid the planning process on the St. Lawrence River. Data were gathered from a number of sources for 12 stations along the main channel of the international section of the river as shown in figure 1 and listed in table 1.

The primary sources of information were published by the Department of Civil and Environmental Engineering, Clarkson College, under the general series "Winter Flow, Ice, and Weather Conditions of the Upper St. Lawrence

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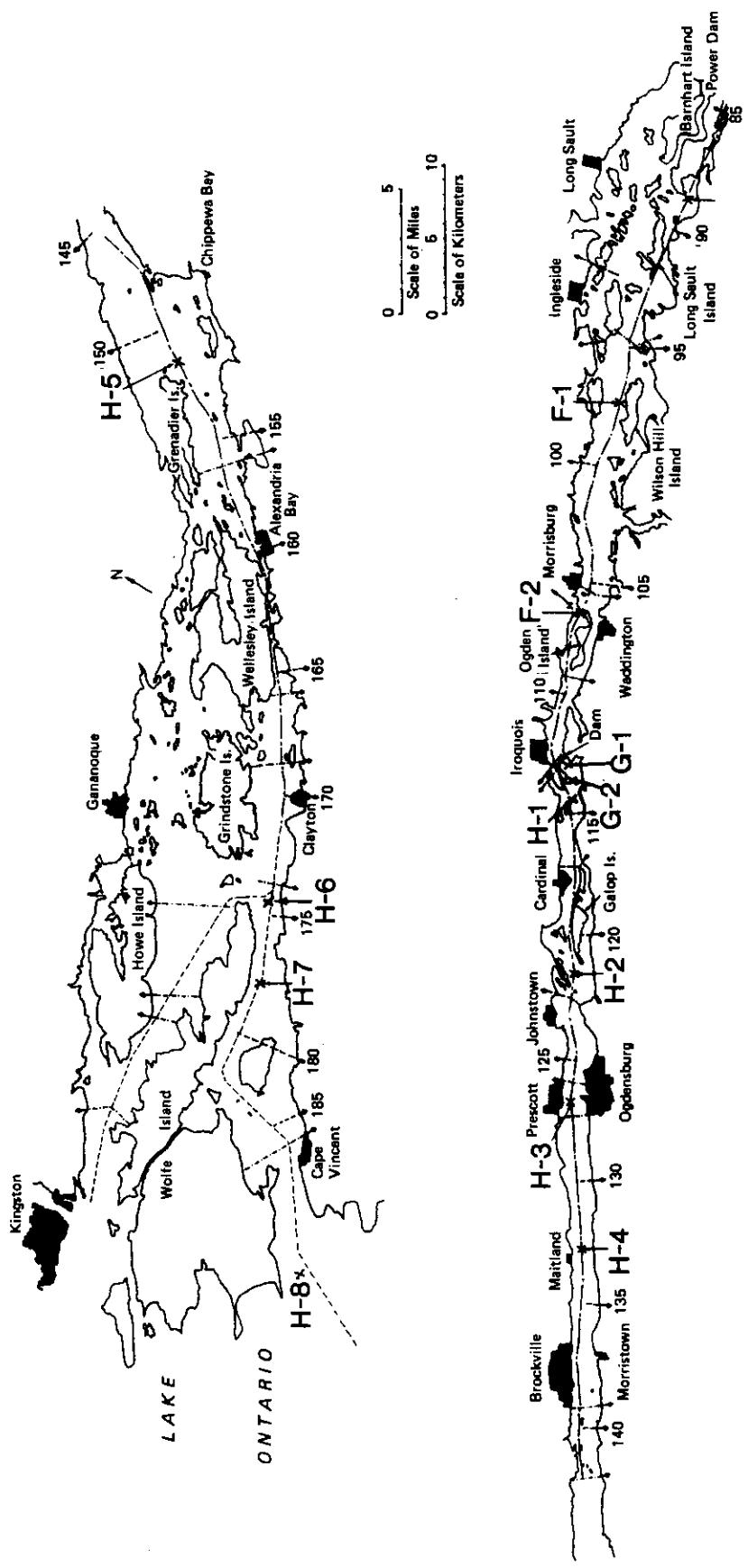


FIGURE 1.—Location of 12 observation sites, St. Lawrence River.
Numbers (e.g., 185) indicate distance from Montreal, Que., in miles).

TABLE 1.--*Location of ice thickness measurement sites
(adapted from Shen and Yapa, 1982)*

Station	Latitude	Longitude	Location
F1	44°56'27"	75°01'57"	Opposite buoy 63 Chrylser Park; mile 96
F2	44°52'52"	75°12'07"	Foot of Ogden Island opposite light 92; mile 108
G1	44°50'05"	75°18'36"	Iroquois Lock opposite tile wall
G2	44°49'26"	75°19'05"	Iroquois Lock opposite light 111
H1	44°48'44"	75°18'45"	Toussaint Island opposite light 114
H2	44°44'44"	75°26'12"	Upper Drummond Island at light 128; mile 121
H3	44°41'32"	75°31'32"	One mile above Boom-Prescott; mile 127
H4	44°37'46"	75°36'25"	Opposite Maitland (stone tower); mile 133
H5	44°26'05"	75°49'33"	Lower Grenadier Island; mile 150
H6	44°13'46"	75°10'09"	Lower end Wolfe Island
H7	44°12'15"	75°14'06"	Wolfe Island Bandford Point opposite light; mile 179
H8	44°05'00"	75°26'00"	Lake Ontario opposite Big Sand Bay; mile 192

River, 1971-81." Volume 1 (Shen *et al.*, 1982) contains weekly ice cover charts derived from aerial photographic mosaics. Volume 2 (Shen and Yapa, 1982) lists ice stratigraphy observations taken in midchannel areas by the St. Lawrence Seaway Authority in Cornwall, Ont. These 12 observation sites defined the points at which freeze-up and breakup dates were determined.

Other sources of data were the annual navigation season extension studies (St. Lawrence Seaway Authority, 1972-81) and the annual St. Lawrence Power Project report of ice phenomena (Power Authority of the State of New York and Ontario Hydro, 1972-81).

Two other studies recently published provide histories of ice cover chronology in the Great Lakes. The NOAA Great Lakes ice atlas is based on 20 years of observation (Assel *et al.*, 1983). Maps in the atlas use a 5-km grid size, so they cannot be used to analyze ice on the connecting channels other than the Detroit River. A recent study of ice events on the St. Marys River (Greene, 1983) does provide detailed freeze-up and breakup dates over a 10-year period for a number of stations established along that river.

2. THE ICE COVER DATA TABLES

Table 2 provides a summary of the ice information for each station, listing the mean date of freeze-over, mean date ice free, mean duration of the solid ice cover, mean maximum ice thickness, and the mean date of maximum ice thickness. Note that the mean duration of ice in this table is not always equal to the interval between the mean date of freeze-over and mean date on which the river was ice free. Tables 3-26 summarize ice events (even-numbered tables) and ice event observations (odd-numbered tables) at the 12 stations. At station H-1 (table 12), for example, there is no date of freeze-over for the abnormally warm 1974-75 season. However, the mean duration in table 2 does reflect the fact that there was a season with no ice cover.

The ice event dates were determined by finding bracketing evidence for an ice cover event. For example, in assigning a freeze-over date to a particular station for a given season, we scanned the data sources for the last date when there was evidence of open water and the first date when there was evidence of an ice cover. These two dates are listed in the even-numbered tables for each station. The single dates shown in the odd-numbered tables were determined by finding the midpoint between the two dates of observation.

3. INTERPRETING THE DATA

Criteria used to interpret the ice cover and thickness data are listed below:

1. If there was a large body of open water less than 1/4 mile from the station, then the station was considered to be in open water, unless the Ice Thickness Report indicated ice cover.
2. When the ice thickness was less than 10 cm all season, we assumed there was only an intermittent, thin ice cover throughout the season.
3. In the cases of intermittent, thin ice all season, we assigned the value 5 cm for the maximum ice thickness. Observed values ranged from 2 cm to 10 cm.
4. In the cases where there were no data available on maximum ice thickness, but it was evident from other data sources that ice existed briefly, maximum ice thickness was set at 5 cm.

TABLE 2.--Summary of mean dates of ice events,
upper St. Lawrence River, 1971-81

Station	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
F-1	Jan. 7	Mar. 21	73	55	Mar. 5
F-2	Jan. 13	Mar. 5	52	56	Feb. 18
G-1	Jan. 6	Mar. 20	73	47	Feb. 26
G-2	Jan. 1	Mar. 20	79	50	Feb. 24
H-1	Jan. 17	Mar. 5	42	38	Feb. 10
H-2	Jan. 16	Feb. 25	38	32	Feb. 2
H-3	Jan. 11	Mar. 9	55	30	Feb. 17
H-4	Jan. 12	Mar. 8	48	28	Feb. 14
H-5	Jan. 8	Mar. 7	49	23	Feb. 9
H-6	Jan. 6	Mar. 10	63	--	--
H-7	Jan. 7	Mar. 14	60	27	Feb. 11
H-8	Jan. 1	Mar. 23	65	39	Feb. 24

5. During some seasons, it appears that there may have been intermittent thaw events. If a station demonstrated a solid cover except for one such event, the thaw was noted, but was not reflected in the season duration value.

6. For all seasons with little or no ice cover, the season duration was set at 5 days so that the 10-year mean duration would be influenced by such a season. In these cases, no date of maximum ice thickness was assigned.

7. During some seasons with little ice cover, it was possible to assign a first ice cover formation date and a last breakup of ice cover, but these dates were not used to compute a duration value.

8. In those cases where there were less than 10 years of data for a given parameter, no standard deviation was calculated.

4. WINTER SEVERITY 1971-81

Tables 2-26 present data for the 10 winter seasons beginning in December 1971 and ending in April 1981. Their use must be guided, however, by some understanding of the general climate during that period. Assel (1980b) provides a means of looking at recent air temperatures in the Great Lakes region in the context of an 80-year record.

TABLE 3.—Summary of ice events, station F-1

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 17	Apr. 16	90	62	Mar. 20
1972-73	Jan. 7	Mar. 10	62	37	Feb. 28
1973-74	Jan. 10	Mar. 7	56	52	Feb. 27
1974-75	Jan. 29	Mar. 20	50	36	Feb. 27
1975-76	Jan. 10	Mar. 27	77	65	Mar. 9
1976-77	Dec. 12	Mar. 20	99	70	Mar. 8
1977-78	Jan. 2	Apr. 2	90	70	Mar. 28
1978-79	Jan. 6	Mar. 25	78	64	Feb. 27
1979-80	Jan. 23	Mar. 25	62	38	Mar. 4
1980-81	Dec. 22	Feb. 21	62	58	Feb. 10
Mean	Jan. 7	Mar. 21	73	55	Mar. 5
Stan. Dev.	14	15	17	14	13

TABLE 4.—Summary of ice event observations, Station F-1

Season	Dates of freeze over	Dates ice free
1971-72	Jan. 16-Jan. 18	Apr. 12-Apr. 21
1972-73	Jan. 6-Jan. 8	Mar. 7-Mar. 14
1973-74	Jan. 8-Jan. 11	Mar. 6-Mar. 8
1974-75	Jan. 23-Feb. 4	Mar. 19-Mar. 21
1975-76	Jan. 8-Jan. 12	Mar. 26-Mar. 27
1976-77	Dec. 10-Dec. 15	Mar. 18-Mar. 22
1977-78	Dec. 30-Jan. 4	Mar. 30-Apr. 6
1978-79	Jan. 5-Jan. 6	Mar. 21-Mar. 28
1979-80	Jan. 16-Jan. 29	Mar. 19-Mar. 28
1980-81	Dec. 19-Dec. 25	Feb. 17-Feb. 23

TABLE 5.--Summary of ice events, station F-2

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 27	Mar. 31	64	56	Mar. 24
1972-73	Jan. 9	Jan. 23	14	29	Jan. 16
1973-74	Jan. 10	Mar. 2	51	69	Feb. 11
1974-75	Jan. 31	Feb. 28	28	41	Feb. 18
1975-76	Jan. 13	Mar. 9	56	67	Feb. 24
1976-77	Dec. 26	Mar. 12	77	69	Mar. 1
1977-78	Jan. 8	Mar. 26	77	70	Mar. 15
1978-79	Jan. 10	Mar. 15	64	70	Feb. 20
1979-80	Jan. 30	Feb. 28	29	30	Feb. 12
1980-81	Dec. 26	Feb. 19	56	56	Jan. 20
Mean	Jan. 13	Mar. 5	52	56	Feb. 18
Stand. Dev.	13	19	21	17	21

TABLE 6.--Summary of ice event observations, station F-2

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 26-Jan. 27	Mar. 27-Apr. 4
1972-73	Jan. 8-Jan. 9	Jan. 17-Jan. 29
1973-74	Jan. 8-Jan. 11	Feb. 27-Mar. 4
1974-75	Jan. 30-Feb. 1	Feb. 27-Mar. 4
1975-76	Jan. 12-Jan. 13	Feb. 24-Mar. 9
1976-77	Dec 16 - Dec 26	Mar 3 - Mar 15
1977-78	Jan. 7-Jan. 9	Mar. 24-Mar. 28
1978-79	Jan. 9-Jan. 11	Mar. 13-Mar. 17
1979-80	Jan. 29-Jan. 30	Feb. 26-Feb. 28
1980-81	Dec. 25-Dec. 26	Feb. 17-Feb. 20

TABLE 7.--Summary of ice events, station G-1

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 12	Apr. 14	93	39	Mar. 15
1972-73	Jan. 7	Mar. 8	60	35	Feb. 28
1973-74	Jan. 10	Mar. 7	56	56	Feb. 27
1974-75	Feb. 1	Mar. 12	39	31	Feb. 18
1975-76	Jan. 13	Mar. 24	71	64	Mar. 9
1976-77	Dec. 19	Mar. 12	84	43	Feb. 22
1977-78	Dec. 28	Apr. 2	96	58	Feb. 25
1978-79	Dec. 26	Mar. 22	87	50	Feb. 27
1979-80	Jan. 20	Mar. 24	64	34	Feb. 19
1980-81	Dec. 22	Mar. 11	80	63	Feb. 10
Mean	Jan. 6	Mar. 20	73	47	Feb. 26
Stand. Dev.	14	13	18	12	9

TABLE 8.--Summary of ice event observations, station G-1

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 8-Jan. 16	Apr. 7-Apr. 21
1972-73	Jan. 6-Jan. 8	Mar. 7-Mar. 8
1973-74	Jan. 8-Jan. 11	Mar. 6-Mar. 8
1974-75	Jan. 30-Feb. 4	Mar. 11-Mar. 26
1975-76	Jan. 12-Jan. 13	Mar. 16-Mar. 29
1976-77	Dec. 16-Dec. 22	Mar. 8-Mar. 15
1977-78	Dec. 27-Dec. 28	Mar. 30-Apr. 6
1978-79	Dec. 22-Dec. 29	Mar. 21-Mar. 22
1979-80	Jan. 16-Jan. 24	Mar. 9-Mar. 28
1980-81	Dec. 19-Dec. 25	Mar. 5-Mar. 17

TABLE 9.--Summary of ice events, station G-2

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Dec. 31	Apr. 14	106	61	Mar. 15
1972-73	Dec. 26	Mar. 10	75	51	Feb. 28
1973-74	Jan. 9	Mar. 7	57	45	Jan. 24
1974-75	Jan. 18	Mar. 14	55	36	Feb. 18
	(open water Feb. 27-Mar. 10)				
1975-76	Dec. 19	Mar. 20	93	61	Mar. 9
1976-77	Dec. 19	Mar. 17	89	55	Mar. 5
1977-78	Dec. 27	Apr. 1	96	62	Mar. 7
1978-79	Jan. 1	Mar. 20	78	51	Feb. 27
1979-80	Jan. 20	Mar. 21	61	30	Feb. 16
1980-81	Dec. 22	Mar. 11	80	53	Feb. 10
	(open water Feb. 27-Mar. 5)				
Mean	Jan. 1	Mar. 20	79	50	Feb. 24
Stand. Dev.	12	12	17	11	15

TABLE 10.--Summary of ice event observations, station G-2

Season	Dates of freeze-over	Dates ice free
1971-72	Dec. 22-Jan. 8	Apr. 7-Apr. 21
1972-73	Dec. 17-Jan. 2	Mar. 8-Mar. 11
1973-74	Jan. 8-Jan. 10	Mar. 6-Mar. 8
1974-75	Jan. 15-Jan. 21	Mar. 10-Mar. 17
	(open water Feb 27-Mar 10)	
1975-76	Dec. 19-Dec. 29	Mar. 18-Mar. 22
1976-77	Dec. 16-Dec. 22	Mar. 15-Mar. 18
1977-78	Dec. 26-Dec. 28	Mar. 30-Apr. 3
1978-79	Dec. 28-Jan. 4	Mar. 19-Mar. 21
1979-80	Jan. 16-Jan. 24	Mar. 19-Mar. 23
1980-81	Dec. 19-Dec. 25	Mar. 5-Mar. 17
	(open water Feb 27-Mar 5)	

TABLE 11.--Summary of ice events, station H-1

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Feb. 3	Apr. 4	61	(thickness not reported)	
1972-73	Jan. 24	Mar. 7	42	(thickness not reported)	
1973-74	Jan. 15	Feb. 27	43	37	Jan. 24
	(open water Jan. 28-Feb. 4)				
1974-75	(open water all season)		0	0	--
1975-76	Jan. 18	Feb. 24	37	41	Feb. 10
1976-77	Dec. 27	Mar. 12	76	56	Feb. 22
1977-78	Jan. 10	Mar. 22	71	53	Feb. 28
1978-79	Jan. 17	Mar. 3	45	66	Feb. 20
1979-80	Feb. 6	Feb. 12	5	5	--
	(open or unsafe water all season)				
1980-81	Jan. 2	Feb. 15	44	43	Jan. 20
Mean	Jan. 17	Mar. 5	42	38	Feb. 10
Stand. Dev.			25		

TABLE 12.--Summary of ice event observations, station H-1

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 21-Feb. 7	Mar. 31-Apr. 7
1972-73	Jan. 17-Jan. 31	Mar. 7-Mar. 8
1973-74	Jan. 13-Jan. 17	Feb. 26-Feb. 27
	(open water Jan 28-Feb 4)	
1974-75	(open water all season)	
1975-76	Jan. 16-Jan. 19	Feb. 23-Feb. 24
1976-77	Dec. 16-Jan. 6	Mar. 8-Mar. 15
1977-78	Jan. 9-Jan. 10	Mar. 20-Mar. 24
1978-79	Jan. 16-Jan. 18	Feb. 28-Mar. 7
1979-80	Feb. 5-Feb. 6	Feb. 9-Feb. 15
	(open or unsafe water all season)	
1980-81	Dec. 31-Jan. 3	Feb. 13-Feb. 17

TABLE 13.—*Summary of ice events, station H-2*

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Feb. 3	Apr. 6	63	102 (ice ridge on Feb. 9)	Feb. 9
1972-73	Jan. 24	Mar. 2	37	41	Feb. 28
1973-74	Jan. 10	Feb. 22	43	30	Jan. 24
	(open water Jan. 30-Feb. 6)				
1974-75	Feb. 6	Feb. 17	5	5	--
	(open or unsafe all season)				
1975-76	Jan. 13	Feb. 18	36	25	Feb. 5
1976-77	Dec. 27	Mar. 5	69	34	Jan. 28
1977-78	Jan. 8	Mar. 13	64	40	Jan. 24
1978-79	Jan. 6	Feb. 26	51	28	Jan. 23
1979-80	Jan. 31	Feb. 8	5	5	--
	(open or unsafe all season)				
1980-81	Jan. 3	Jan. 27	5	5	--
	(open or unsafe all season)				
Mean	Jan. 16	Feb. 25	38	32	Feb. 2
Stand. Dev.	14	19	25	28	13

TABLE 14.—*Summary of ice event observations, station H-2*

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 31-Feb. 7	Apr. 1-Apr. 12
1972-73	Jan. 17-Jan. 31	Feb. 28-Mar. 5
1973-74	Jan. 8-Feb. 11 (open water Jan 30-Feb 6)	Feb. 18-Feb. 27
1974-75	Feb. 3-Feb. 10 (open or unsafe all season)	Feb. 14-Feb. 21
1975-76	Jan. 12-Jan. 13	Feb. 12-Feb. 23
1976-77	Dec. 16-Jan. 6	Mar. 1-Mar. 8
1977-78	Jan. 6-Jan. 9	Mar. 10-Mar. 15
1978-79	Jan. 5-Jan. 7	Feb. 25-Feb. 27
1979-80	Jan. 30-Feb. 2 (open or unsafe all season)	Feb. 7-Feb. 9
1980-81	Dec. 31-Jan. 6 (open or unsafe all season)	Jan. 25-Jan. 29

TABLE 15.--Summary of ice events, station H-3

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 23	Apr. 4	72	41	Mar. 18
1972-73	Jan. 13	Mar. 8	54	19	Feb. 28
1973-74	Jan. 10	Mar. 3	52	23	Feb. 11
	(open water Jan. 31-Feb. 4)				
1974-75	Jan. 23	Feb. 24	5	5	--
	(open or unsafe all season)				
1975-76	Jan. 12	Feb. 27	46	34	Feb. 10
1976-77	Dec. 19	Mar. 15	87	42	Feb. 6
1977-78	Jan. 5	Mar. 22	76	53	Mar. 7
1978-79	Jan. 8	Mar. 13	64	38	Feb. 20
1979-80	Jan. 22	Mar. 9	47	19	Feb. 1
	(open water Feb. 26-Mar. 6)				
1980-81	Jan. 4	Feb. 19	46	30	Jan. 14
Mean	Jan. 11	Mar. 9	55	30	Feb. 17
Stand.Dev.	11	3	22	14	18

TABLE 16.--Summary of ice event observations, station H-3

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 21-Jan. 26	Mar. 31-Apr. 7
1972-73	Jan. 8-Jan. 17	Mar. 7-Mar. 8
1973-74	Jan. 8-Jan. 11 (open water Jan. 31-Feb. 4)	Feb. 27-Mar. 8
1974-75	Jan. 15-Jan. 30 (open or unsafe all season)	Feb. 21-Feb. 27
1975-76	Jan. 12-Jan. 13	Feb. 24-Mar. 1
1976-77	Dec. 16-Dec. 22	Mar. 8-Mar. 15
1977-78	Jan. 4-Jan. 6	Mar. 20-Mar. 24
1978-79	Jan. 5-Jan. 11	Mar. 7-Mar. 13
1979-80	Jan. 16-Jan. 28 (open water Feb. 26-Mar. 6)	Mar. 6-Mar. 11
1980-81	Dec. 31-Jan. 10	Feb. 17-Feb. 20

TABLE 17.--*Summary of ice events, station H-4*

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Feb. 3	Apr. 3	60	51	Mar. 20
1972-73	Jan. 5	Mar. 8	62	18	Feb. 20
1973-74	Jan. 11	Feb. 24	44	22	Feb. 11
	(open water Jan. 30-Feb. 6)				
1974-75	Jan. 23	Feb. 24	5	5	--
	(open or unsafe all season)				
1975-76	Jan. 2	Feb. 27	56	27	Jan. 27
1976-77	Dec. 27	Mar. 12	76	43	Feb. 9
1977-78	Jan. 9	Mar. 22	72	46	Feb. 25
1978-79	Jan. 11	Mar. 11	59	33	Feb. 20
1979-80	Jan. 22	Mar. 9	5	5	--
	(open or unsafe all season)				
1980-81	Jan. 5	Feb. 19	45	30	Jan. 17
Mean	Jan. 12	Mar. 8	48	28	Feb. 14
Stand. Dev.	12	13	25	16	19

TABLE 18.--*Summary of ice event observations, station H-4*

Season	Dates of freeze over	Dates ice free
1971-72	Jan. 29-Feb. 7	Mar. 31-Apr. 7
1972-73	Jan. 2-Jan. 8	Mar. 7-Mar. 8
1973-74	Jan. 8-Jan. 13	Feb. 21-Feb. 26
	(open water Jan 30-Feb 6)	
1974-75	Jan. 15-Jan. 30	Feb. 21-Feb. 27
	(open or unsafe all season)	
1975-76	Dec. 31-Jan. 5	Feb. 24-Mar. 1
1976-77	Dec. 16-Jan. 6	Mar. 8-Mar. 15
1977-78	Jan. 6-Jan. 12	Mar. 20-Mar. 24
1978-79	Jan. 5-Jan. 17	Mar. 9-Mar. 13
1979-80	Jan. 16-Jan. 29	Mar. 6-Mar. 11
	(open or unsafe all season)	
1980-81	Dec. 31-Jan. 10	Feb. 17-Feb. 20

TABLE 19.--Summary of ice events, station H-5

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 27	Apr. 3	67	41	Mar. 8
1972-73	Jan. 5	Mar. 6	60	18	Feb. 12
1973-74	Jan. 11	Feb. 24	44	19	Feb. 9
	(open water Feb. 1-Feb. 6)				
1974-75	Jan. 23	Mar. 13	5	5	--
	(open or unsafe all season)				
1975-76	Jan. 10	Feb. 17	38	29	Jan. 27
1976-77	Dec. 19	Mar. 8	80	34	Feb. 15
1977-78	Jan. 9	Mar. 22	72	(ice thickness not measured)	
1978-79	Jan. 7	Mar. 10	62	25	Feb. 6
1979-80	Jan. 8	Mar. 7	5	5	--
	(open or unsafe all season)				
1980-81	Dec. 25	Feb. 15	53	32	Jan. 20
Mean	Jan. 8	Mar. 7	49	23	Feb. 9
Stand. Dev.	12	15	26		

TABLE 20.--Summary of ice event observations, station H-5

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 26-Jan. 27	Mar. 31-Apr. 7
1972-73	Jan. 2-Jan. 8	Feb. 28-Mar. 6
1973-74	Jan. 8-Jan. 13	Feb. 21-Feb. 27
	(open water Feb 1-Feb 6)	
1974-75	Jan. 15-Jan. 30	Mar. 10-Mar. 17
	(open or unsafe all season)	
1975-76	Jan. 8-Jan. 12	Feb. 10-Feb. 23
1976-77	Dec. 16-Dec. 22	Mar. 1-Mar. 8
1977-78	Jan. 6-Jan. 12	Mar. 20-Mar. 24
1978-79	Jan. 5-Jan. 11	Mar. 7-Mar. 13
1979-80	Dec. 18-Jan. 29	Mar. 4-Mar. 11
	(open or unsafe all season)	
1980-81	Dec. 19-Dec. 31	Feb. 13-Feb. 17

TABLE 21.--*Summary of ice events, station H-6*

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 12	Apr. 3	82	38	Mar. 8
1972-73	Dec. 28	Mar. 11	74	(thickness not reported)	
1973-74	Jan. 10	Mar. 1	50	(thickness not reported)	
	(open water Jan. 25-Feb. 6)				
1974-75	Jan. 23	Mar. 19	55	(thickness not reported)	
1975-76	Jan. 10	Feb. 27	48	(thickness not reported)	
1976-77	Dec. 19	Mar. 13	85	(thickness not reported)	
1977-78	Jan. 9	Mar. 22	72	(thickness not reported)	
1978-79	Jan. 12	Mar. 5	52	(thickness not reported)	
1979-80	Jan. 8	Mar. 20	72	(thickness not reported)	
	(open water Feb. 15-Mar. 6)				
1980-81	Dec. 25	Feb. 5	43	(thickness not reported)	
Mean	Jan. 6	Mar. 10	63		
Stand. Dev.	11	16	15		

TABLE 22.--*Summary of ice event observations, station H-6*

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 8-Jan. 16	Mar. 31-Apr. 7
1972-73	Dec. 17-Jan. 8	Mar. 7-Mar. 16
1973-74	Jan. 8-Jan. 12	Feb. 21-Mar. 9
	(open water Jan. 25-Feb. 6)	
1974-75	Jan. 15-Jan. 30	Mar. 17-Mar. 21
1975-76	Jan. 8-Jan. 12	Feb. 23-Mar. 1
1976-77	Dec. 16-Dec. 22	Mar. 8-Mar. 18
1977-78	Jan. 6-Jan. 12	Mar. 20-Mar. 24
1978-79	Jan. 5-Jan. 19	Feb. 25-Mar. 13
1979-80	Dec. 18-Jan. 29	Mar. 12-Mar. 28
	(open water Feb. 15-Mar. 6)	
1980-81	Dec. 19-Dec. 31	Jan. 29-Feb. 13

TABLE 23.--Summary of ice events, station H-7

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 24	Apr. 3	70	33	Mar. 18
1972-73	Dec. 28	Mar. 12	75	(thickness not reported)	
1973-74	Jan. 10	Mar. 1	50	(thickness not reported)	
1974-75	Jan. 23	Mar. 1	37	(thickness not reported)	
1975-76	Jan. 10	Mar. 19	55	32	Feb. 8
	(open water Feb. 24-Mar. 9)				
1976-77	Dec. 19	Mar. 12	84	39	Feb. 22
1977-78	Jan. 9	Mar. 27	77	36	Feb. 8
1978-79	Jan. 8	Mar. 10	61	21	Jan. 23
1979-80	Jan. 8	Mar. 15	5	5	--
	(open or unsafe all season)				
1980-81	Dec. 25	Feb. 15	53	23	Jan. 20
Mean	Jan. 7	Mar. 14	60	27	Feb. 11
Stand. Dev.	12	13	22		

TABLE 24.--Summary of ice event observations, station H-7

Season	Dates of freeze-over	Dates ice free
1971-72	Jan. 21-Jan. 27	Mar. 31-Apr. 7
1972-73	Dec. 17-Jan. 8	Mar. 7-Mar. 16
1973-74	Jan. 8-Jan. 12	Feb. 21-Mar. 8
1974-75	Jan. 15-Jan. 30	Mar. 17-Mar. 21
1975-76	Jan. 8-Jan. 12 (open water Feb. 24-Mar. 9)	Mar. 9-Mar. 29
1976-77	Dec. 16-Dec. 22	Mar. 8-Mar. 15
1977-78	Jan. 6-Jan. 12	Mar. 24-Mar. 30
1978-79	Jan. 5-Jan. 11	Mar. 7-Mar. 13
1979-80	Dec. 18-Jan. 29 (open or unsafe all season)	Mar. 11-Mar. 18
1980-81	Dec. 19-Dec. 31	Feb. 13-Feb. 17

TABLE 25.--Summary of ice events, station H-8

Season	Date of freeze-over	Date ice free	Duration of solid ice cover (days)	Maximum ice thickness (cm)	Date of maximum ice thickness
1971-72	Jan. 4	Mar. 31	87	61	Feb. 28
1972-73	Dec. 30	Mar. 3	64	(thickness not reported)	
1973-74	(open or unsafe all season)		5	5	--
1974-75	(open or unsafe all season)		5	5	--
1975-76	Jan. 4	Mar. 19	75	45	Feb. 10
1976-77	Dec. 23	Apr. 18	117	65	Mar. 1
1977-78	Dec. 31	Apr. 10	101	63	Mar. 7
1978-79	Jan. 1	Mar. 22	80	44	Feb. 27
1979-80	Jan. 9	Mar. 15	66	21	Feb. 19
	(open water Feb. 26-Mar. 4)				
1980-81	Jan. 4	Feb. 25	52	42	Feb. 17
Mean	Jan. 1	Mar. 23	65	39	Feb. 24
Stand. Dev.			38		

TABLE 26.--Summary of ice event observations, station H-8

Season	Dates of freeze-over	Dates ice free
1971-72	Dec. 19-Jan. 20	Mar. 20-Apr. 12
1972-73	Dec. 17-Jan. 12	Feb. 27-Mar. 8
1973-74	(open or unsafe all season)	
1974-75	(open or unsafe all season)	
1975-76	Dec. 21-Jan. 18	Mar. 9-Mar. 29
1976-77	Dec. 15-Dec. 31	Apr. 4-May. 1
1977-78	Dec. 19-Jan. 12	Apr. 3-Apr. 17
1978-79	Dec. 22-Jan. 11	Mar. 16-Mar. 22
1979-80	Dec. 18-Jan. 30	Mar. 11-Mar. 18
	(open water Feb. 26-Mar. 4)	
1980-81	Dec. 19-Jan. 20	Feb. 23-Feb. 26

Table 27 summarizes winter severity during the 10-year period of analysis for the Great Lakes region (represented by air temperature data from Duluth, Minn.; Sault Ste. Marie, Mich.; Milwaukee, Wis.; Alpena, Mich.; Cleveland, Ohio; and Rochester, N.Y.). The first column shows the departure from the 80-year mean maximum accumulated degree-days in units of standard deviation (Hinkel, 1983). For example, the air temperatures for 1976-77 were nearly two standard deviations colder than normal.

Column two shows the same departure from the 80-year normal for Rochester, the closest city to the St. Lawrence River of those used in Assel's (1980a, 1980b) analysis. During this period, there were an equal number of colder and warmer seasons, but the colder years tended to be closer to the extremes than the warmer years.

Air temperature records at Ogdensburg, N.Y., (lying at the midpoint of the international section of the St. Lawrence River) were also examined for comparison with Assel's severity study. Maximum accumulated freezing degree-days for just these 10 years were ranked from coldest (1) to warmest (9). These rankings can then be compared to a similar ranking for Rochester in column 3. The correspondence between the two columns indicates that winter severity for the St. Lawrence River can be roughly approximated by conditions at Rochester.

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TABLE 27.—*Winter severity*

Years	Great Lakes Region	Rochester	Rochester Rank	Ogdensburg Rank
1971-72	0.50	-0.33	7	6
1972-73	-0.76	-1.06	8	8
1973-74	-0.07	-0.46	(data not available for Ogdensburg)	
1974-75	-0.62	-1.40	9	9
1975-76	0.22	-0.04	6	4
1976-77	1.70	1.37	1	2
1977-78	1.20	1.29	2	1
1978-79	1.32	1.05	3	3
1979-80	-0.09	0.32	5	7
1980-81	0.29	0.93	4	5

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